CLAIMS

What is claimed is:

1.   A method to create a fault surface from a three-dimensional seismic data volume, comprising:

constructing an initial fault surface in three-dimensions, said surface containing at least two fault sticks, the fault sticks being from the same fault but from different slices of the seismic data volume, each fault stick being defined by at least two fault nodes; and

reconstructing the initial fault surface to fit the three-dimensional seismic data, said reconstruction using an iterative evolution of a deformable surface model of the fault surface, said evolution being based on smoothness of the fault surface and a fault-indicating parameter of each location on the fault surface.

2.   The method of claim 1, wherein the fault nodes are obtained by manual interpretation of the data volume.

3.   The method of claim 1, wherein the data volume slices comprise a vertical slice and an horizontal slice.

4.   The method of claim 1, wherein the seismic data comprise seismic amplitude discontinuity data, and the fault-indicating parameter is the seismic amplitude discontinuity.

5.   The method of claim 4, wherein the iteration of the deformable surface model uses local minimization of an energy function of such surface, said function having as variables the curvature of the fault surface and the discontinuity in seismic amplitudes, each variable being itself a function of spatial location on the fault surface, and wherein the iteration is terminated when the change in the surface energy relative to the preceding iteration is less than a pre-determined value.

6.   The method of claim 5, wherein the energy function is a weighted sum of an internal force and an external force, said internal force being a function of curvature of

the fault surface and said external force being a function of seismic amplitude discontinuity on the fault surface.

7.   The method of claim 1, wherein the seismic data comprise seismic amplitude coherency data, and the fault-indicating parameter is the seismic amplitude coherency.

8.   The method of claim 7, wherein the iteration of the deformable surface model uses local minimization of an energy function of such surface, said function having as variables the curvature of the fault surface and the coherency in seismic amplitudes, each variable being itself a function of spatial location on the fault surface, and wherein the iteration is terminated when the change in the surface energy relative to the preceding iteration is less than a pre-determined value.

9.   The method of claim 8, wherein the energy function is a weighted sum of an internal force and an external force, said internal force being a function of curvature of the fault surface and said external force being a function of seismic amplitude coherency on the fault surface.

10.   The method of claim 6 or claim 9, wherein the weighted sum uses a weighting factor λ for the internal force and a weighting factor $(1 - \lambda)$ for the external force, λ being selected to provide substantially equal contributions to the energy function from the internal and external forces, except for noisy data where λ is chosen substantially equal to 1.

11.   The method of claim 1, wherein a fault surface is assumed to be a single-valued function of two orthogonal geographic coordinates, and all voxels in the fault surface are allowed to move only in the third orthogonal direction in the course of iterative deforming of the surface model, said single-valued function being in the form of $x = f(y,z)$ if the angle between a fault surface and the y-z plane is less than 45 degrees, and $y = f(x,z)$ if the angle between a fault surface and the y-z plane is greater than 45 degrees, the coordinate z being in the vertical direction.

12.   The method of claim 1, wherein constructing an initial fault surface comprises the steps of:

(a)   generating a pre-selected density of fault points along each fault stick by performing linear interpolation between fault nodes;

(b)   identifying the extent of the boundaries of the fault surface by using the interpolated fault points from step (a); and

(c)   constructing an initial fault surface within said boundaries by using bilinear interpolation of the interpolated fault points from step (a).

13.   The method of claim 1, wherein the reconstructed fault surface is defined by a discrete set of fault sticks.

14.   The method of claim 1, wherein the seismic data comprise seismic amplitude discontinuity and coherency data, and the fault-indicating parameter is a combination of the seismic amplitude discontinuity and the seismic amplitude coherency.